CLAIMS

What is claimed is:

1. A rapid insertion assembly for placing and withdrawing a component to and from a predetermined location, comprising:

a shuttle adapted to support the component proximate a first end, and having a second distal end with first and second pieces of magnetic material coupled thereto and spaced apart a predetermined distance;

a guide-way supporting the shuttle, permitting the shuttle to move in a first direction between a first IN position where the component lies substantially in the location and a second OUT position where the component does not lie substantially in the location;

a base for supporting the guide-way;

a third magnetic piece and coil sharing a common magnetic axis, coupled to the base and located between the spaced-apart first and second pieces, so that when the shuttle reaches the IN position the first and third piece are in contact forming a first magnetic latch to releasably hold the shuttle in the IN position and when the shuttle reaches the OUT position the second and third pieces form a second magnetic latch to releasably hold the shuttle in the OUT position, wherein a magnetic pulse created by the coil causes either magnetic latch to release, freeing the shuttle from the IN or OUT position; and

one or more springs coupled between the shuttle and the base, the one or more springs storing energy when the shuttle is in either the IN or OUT position, and transferring such stored energy to the shuttle when either magnetic latch is released, thereby causing the shuttle to move to the opposite OUT or IN position.

2. The assembly of claim 1 wherein the first and second pieces of magnetic material are keepers and the third piece of magnetic material is a permanent magnet.

3. The assembly of claim 1 wherein the first and second pieces of magnetic material are permanent magnets and the third piece of magnetic material is a keeper.

4. The assembly of claim 1 wherein the third piece of magnetic material comprises first and second portions, the first portion located at one end of the coil facing the first piece of magnetic material and the second portion located at an opposed end of the coil facing the second piece of magnetic material, the first piece and the first portion forming the first magnetic latch and the second piece and the second portion forming the second magnetic latch.

5. The assembly of claim 1 wherein the first and second pieces are substantially U-shaped with the open ends of the U's facing each other.

6. The assembly of claim 1 further comprising a second coil and a magnetic armature, one of which is coupled to the base and the other of which is coupled to the shuttle, so that, when a current pulse is applied to the second coil, the shuttle moves toward one of the IN or OUT positions.

7. A system for moving a shuttle between spaced-apart, first and second opposed bi-stable positions, comprising:

one or more sensors for determining whether the shuttle is in the first or second bi-stable position;

an assembly for providing an attractive magnetic force thereby forming a magnetic latch that releasably holds the shuttle in either the first or second bi-stable position;

a first coil magnetically coupled to a portion of the assembly, wherein when the coil is provided with a sufficient current pulse, it generates a magnetic field that temporarily overcomes the attractive magnetic force forming the magnetic latch, thereby causing the magnetic latch to release;

a controller electrically coupled to the one or more position sensors and to the first coil and having an external input, wherein the controller receives shuttle position data from the one or more sensors and a position change command via the external input, then if the commanded position is different than the current shuttle position, the controller supplies the sufficient current pulse to the first coil thereby causing the magnetic latch to release so that the shuttle transits to the opposite bi-stable position.

8. The system of claim 7 further comprising a second coil, the second coil electrically coupled to the controller, and further comprising an armature coupled to the shuttle and engaging the second coil, wherein the armature is activated by the second coil to place the shuttle in one of its first or second bi-stable states in response to one or more current pulses delivered by the controller to the second coil.

9. The system of claim 7 further comprising one or more TLM sensors coupled to the controller for determining the health of at least one of the one or more sensors or the first coil or both.

10. A method for moving a shuttle adapted to carry a filter between bi-stable first and second opposed end positions through an intermediate position, the shuttle having one or more position measuring devices, a first magnetic latch for releasably holding the shuttle in the first bi-stable position and a second magnetic latch for releasably holding the shuttle in the second bi-stable position, and one or more coils for releasing the bi-stable latches and moving the shuttle from the intermediate position to one of the first or second end positions, the method comprising:

determining whether the shuttle is located in the first end position, the intermediate position or the second end position;

if in the first or second end positions, storing the determined location or if in the intermediate position, placing the shuttle in one of the first or second locations and then storing the location;

before, during or after the foregoing determining and storing steps, receiving a desired shuttle location command for the first or second position; and

if the desired shuttle location is for the stored location repeating the receiving step, or if the desired shuttle location is not for the stored location, sending a signal to the one or more coils to release whichever magnetic latch is holding the shuttle and thereby move the shuttle to the desired shuttle location.

11. The method of claim 10 where the shuttle has associated therewith TLM sensors adapted to provide data on the health of the one or more position sensors and the one or more coils, wherein the method further comprises prior to the first determining step:

collecting data from the TLM sensors;

comparing the collected data to predetermined constants to determine whether the states of the one or more position sensors and the first coil are good or bad; and

if the states are good, proceeding to the first determining step or if the states are bad, repeating the TLM data collecting step.

12. The method of claim 11 further comprising after the comparing step, if the states are bad, issuing an error report before repeating the collecting step.

13. The method of claim 10 further comprising, after the sending step, checking the shuttle position to determine whether or not the shuttle has moved to the desired shuttle location, and if not, issuing an error report and if so, proceeding to the receiving step.

14. The method of claim 13 further comprising after the checking step, if the shuttle has not moved to the desired shuttle location then, before issuing the error report, repeating the sending step.

15. The method of claim 14 further comprising counting the number of times that the sending step has been repeated and if it exceeds a predetermined number, omitting further sending steps and issuing the error report.

16. The method of claim 10 further comprising prior to the receiving step, placing the shuttle in a predetermined park position.

17. An apparatus for rapidly moving a filter IN and OUT of an optical beam; comprising:

first and second spaced-apart pieces of magnetic material;

a third region of magnetic material and a coil, wherein the third region and the coil share a common magnetic axis;

a shuttle that carries the filter proximate a first end and the first and second spaced-apart pieces of magnetic material near an opposite end;

a low friction guide-way that supports the shuttle;

a base that supports the guide-way and the third magnetic piece and coil, the third magnetic piece and coil being located between the first and second pieces;

one or more springs coupled between the shuttle and the base, adapted to store energy when the shuttle is IN or OUT; and

wherein, when the shuttle is IN the first piece and a first portion of the third piece form a first magnetic latch to releasably hold the shuttle IN and when the shuttle is OUT the second piece and a second portion of the third piece form a second magnetic latch to releasably hold the shuttle OUT, and activating the coil weakens the magnetic attraction within the magnetic latch, thereby freeing the shuttle to move, driven by the one or more springs, to the opposite OUT or IN position.

18. The apparatus of claim 17 wherein the first and second pieces are keepers and the third piece is a magnet.

19. The apparatus of claim 17 wherein the first and second portions of the third piece are separated with the coil in between.

20. A rapid insertion assembly for placing and withdrawing a component to and from a predetermined location, comprising:

a base;

a shuttle element translationally mounted in at least partially within the base and moveable between at least an extend position and a retract position;

a first magnetic piece coupled to the shuttle element;

a second magnetic piece coupled to the shuttle element and spaced apart from the first shuttle element;

a third magnetic piece coupled to the base and disposed between the first and second magnets, the third magnet magnetically coupled to the first magnet when the shuttle element is in the extend position and magnetically coupled to the second magnet when the shuttle element is in the retract position; and

one or more springs coupled between the shuttle element and the base and configured to (i) bias the shuttle element toward the extend position at least when the shuttle element is in the retract position and (ii) bias the shuttle element toward the retract position at least when the shuttle element is in the extend position.